

LANCE Enhancement Request
Near-Real Time Data from the Lightning Imaging Sensor

Overview:

The purpose of the suggested enhancement is to generate lightning products from the Lightning Imaging Sensor (LIS) instrument on the Tropical Rainfall Measuring Mission (TRMM) satellite on a near-real time basis, display the products on the LANCE LIS web sites, and create browse for the LANCE Rapid Response System.

Required Information for Enhancement Request:

1. Identify and summarize the effort.

1a. Who is requesting the effort? (User)

- Dr. David Bright, NOAA NWS Aviation Weather Center, Chief of the Aviation Support Branch

- Dr. Mark DeMaria, NOAA NESDIS, Chief of the Regional and Mesoscale Meteorology Branch

1b. Who is completing the effort? (Provider)

- GHRC DAAC, repurposing LANCE AMSR-E equipment

1c. Is there a HQ or Science sponsor?

- Dr. Ramesh Kakar, NASA Headquarters, Weather Focus Area Leader
- Dr. Frank Lindsay, NASA Headquarters, Disasters Program Manager
- Dr. Richard Blakeslee, NASA MSFC, PI for the Lightning Imaging Sensor

2. Scientific and/or application objective achieved through enhancement:

2a. Say a few words about how this enhancement will improve science or contribute to the application of the NRT data?

The Lightning Imaging Sensor is a space-based instrument used to detect the distribution and variability of total lightning (cloud-to-cloud, intracloud, and cloud-to-ground) during both daytime and nighttime. Lightning detection from space allows monitoring of areas that have few ground stations. While the primary goal of the LIS has been to create long-term climate data records of lightning around the world for research, generating lightning products in near-real time and combining them with other sensor data could certainly enhance rapid response systems in such areas as forest fire detection, severe thunderstorms, and possibly as a precursor to tornado development. Currently there are no lightning products in the LANCE or Rapid Response systems.

Products from the LIS are currently generated in two ways:

- Standard, non-quality controlled (non-QC), daily products generated with Level 0 science files and definitive ephemeris. These non-QC data are typically available within 16 hours of the last observation.

- Monthly quality controlled (QC) products (man in the loop inspected) are generated with Level 0 science files and definitive ephemeris as time permits and after all products have been received for the month. These QC products are typically available one month after last data acquisition.

These products have been generated at the GHRC since the launch of TRMM. We propose to provide the near-real time LIS products for LANCE within 2 hours (~90 min) of data observation, thereby reducing the delay in generating science-quality lightning products by 16 hours.

In addition to the existing LIS on TRMM, there are plans underway to fly the LIS flight spare for TRMM on the International Space Station (ISS). The ISS LIS will provide real time lightning data (one to three minutes latency) using the ISS Low Rate Telemetry channel. This capability was desired by NASA Headquarters and strongly endorsed by a number of NOAA operational partners, including the National Weather Service (NWS) Pacific Region, NWS Ocean Prediction Center, the NWS Aviation Weather Center, and the NOAA National Hurricane Center. The ISS LIS will provide real time lightning for data sparse regions, especially over the ocean. The ISS LIS was approved for the International Space Station in mid-April 2013 with launch and operations in early 2016 aboard a SpaceX-10 launch vehicle. The LANCE ISS lightning product could also support Fire Weather in the data sparse regions of the western United States. These data will be used for storm warnings, oceanic aviation safety and international Significant Meteorological (SIGMET) advisories, long-range lightning system validation, and hurricane rapid intensification evaluations. Prior to the availability of ISS LIS real time data, TRMM LIS data (quick look latency on the order of 90 minutes) can be used to develop and test the real time lightning products in LANCE so that the products will be immediately available to users upon the launch of ISS LIS in late 2015. In addition, the GOES-R Geostationary Lightning Mapper (GLM) will be launched in late 2015. GLM data could also be used to support a real time LANCE lightning product, since it will provide continuous observations over its assigned region (east, central or west) of the continental U.S.

3. Concept of operations:

We note that the LIS science processing software currently runs on the Silicon Graphic Inc. SGI IRIX operating system. The LIS Science Team has provided an adaptation of this software for “quick look” processing, using near real-time (NRT) Level 0 science data as downlinked from the satellite (not aggregated into daily granules) and predictive ephemeris. Because the remaining SGI IRIX servers are approaching end of life, the Science Team plans to port both versions of the LIS algorithm to Linux during 2013. Therefore, we would need to implement LANCE for LIS in two phases, first using the GHRC’s LIS SGI for processing, then transitioning to the repurposed LANCE AMSR-E Linux processing servers when a Linux version of the algorithm is available. In both phases, the LANCE AMSR-E FTP servers would be used for data distribution.

3a. Location of functionality

The functionality will be co-located with the GHRC DAAC and initially will leverage the existing GHRC Ingest Server and LIS SGI processing system, as shown in Figure 1. Following a successful evaluation period and the receipt of LIS science software that will run on the Linux servers, we plan to repurpose the LANCE AMSR-E Linux data distribution systems (two strings in separate locations and on different networks) to host the LANCE LIS data and web servers, as shown in Figure 2. The GHRC DAAC will provide user services.

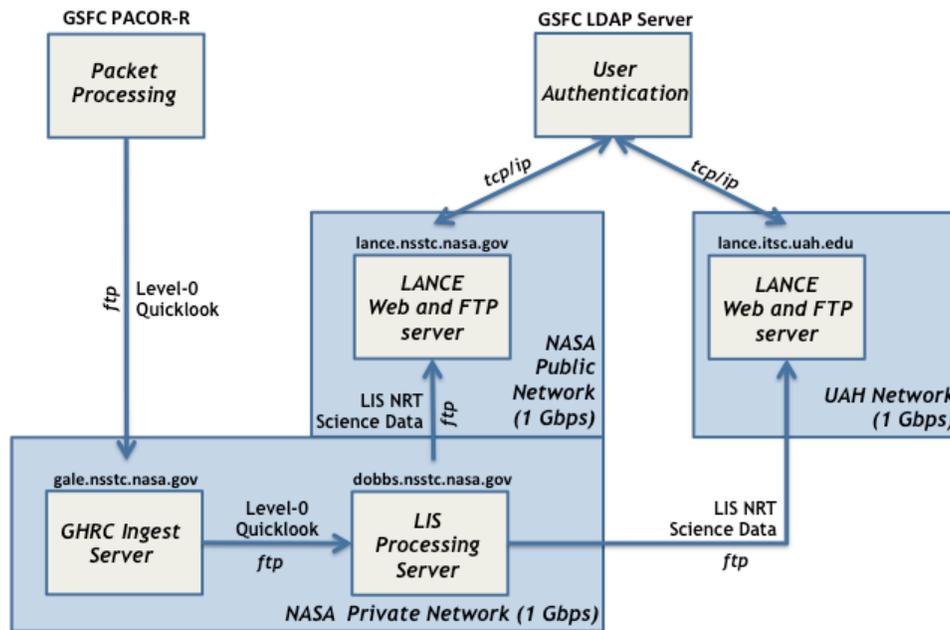


Figure 1. LANCE LIS proposed system architecture and data flow (INTERIM)

3b. Development, integration and testing process

Migration of the quicklook science processing code from the LIS SCF to the GHRC LIS processing systems should be very straightforward. The LIS Science Team has developed and tested the software. The GHRC will need to implement ingest software for the NRT data and predictive ephemeris files from the GSFC Packet Processor (PACOR) system, as well as code to transfer the lightning products available to the repurposed LANCE AMSR-E Linux system. We will work with ESDIS engineers to determine what lightning products might enhance the Rapid Response system.

The LIS Science Team plans to port the LIS processing software to Linux in FY13. In FY14 the GHRC will migrate the LANCE LIS processing from the LIS SGI system to the repurposed LANCE AMSR-E backend processing systems.

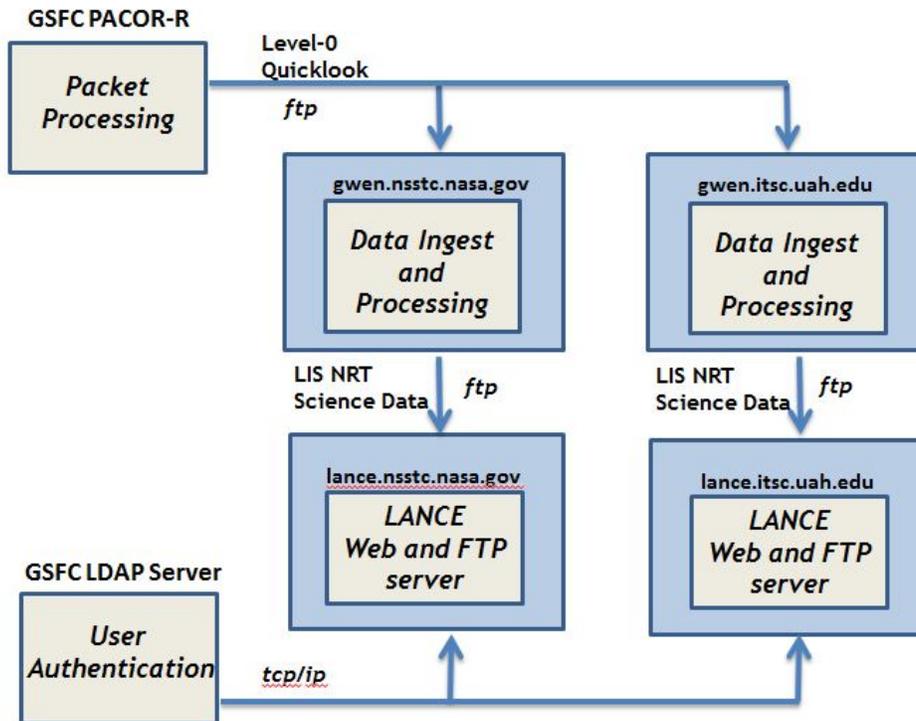


Figure 2. LANCE LIS proposed system architecture and data flow (Full Redundancy)

3c. *Support (FTEs) for development and sustaining engineering*

LANCE LIS will leverage the considerable systems engineering, design and processes that went into developing LANCE AMSR-E, product generation software from the Science Team, and operations experience with LIS standard products. The following is a breakout of the effort in full time equivalent (FTEs) for the development of the requirements and the development, implementation, and testing of the data flows in LANCE LIS:

- Development of detailed requirements (senior systems engineering and development teams)
- Development, integration, and testing of NRT ingest stream from PACOR (development and operations teams)
- Installation, configuration and testing of LIS quicklook software (development and operations teams)
- Coordination with LANCE Central for new data products (systems engineering and user services)
 - Latency metrics reporting
 - Rapid Response imagery
 - User registration
- System and user documentation, FAQ, web pages (user services)
- Routine operations (operations team, systems administrator)
- Sustaining engineering (senior programmer/system administrator)

3d. What is the plan for approving the work is completed?

The LIS Science Team will validate and approve the NRT lightning products generated by LANCE LIS.

4. Notional schedule:

4a. How long will it take to complete this work? When would it start?

The GHRC will begin work on this task as soon as we receive approval to start. We expect to make LIS NRT data available through LANCE within two months, and browse imagery available through the Rapid Response system within four months. The LANCE LIS effort will continue as long as the instrument remains operational.

5. Endorsements:

- David Bright, NOAA NWS NCEP Aviation Weather Center, Aviation Support Branch
- Mark DeMaria, NOAA NESDIS / Center for Satellite Applications and Research, Regional and Mesoscale Meteorology Branch

From: David Bright - NOAA Federal <david.bright@noaa.gov>

Subject: Re: Letter of Endorsement for TRMM LIS follow-on on the ISS

Date: March 1, 2013 4:41:10 PM CST

To: "Harrison, Sherry" <SHarrison@itsc.uah.edu>

Cc: Bruce Entwistle - NOAA Federal <bruce.entwistle@noaa.gov>, "Conover, Helen" <HConover@itsc.uah.edu>, "Regner, Kathryn" <kregner@itsc.uah.edu>, Bob Maxson - NOAA Federal <bob.maxson@noaa.gov>

The NOAA/NWS Aviation Weather Center (AWC) along with the NOAA/NWS Aviation Weather Testbed (AWT) strongly supports your proposal to produce lightning products from the Lightning Imaging Sensor (LIS) instrument currently on TRMM, and making those data available to the AWC and AWT through the NASA Lance system. The AWC is responsible for providing weather forecasts and warnings to the U.S. and international aviation communities to support safe and efficient flight. Convection and lightning are particularly hazardous to aviation and important to air traffic flow management and flight planning. If the LIS data can be made available to the AWT for testing and evaluation, and then the AWC for operations via the NASA LANCE system, there are potentially huge near-term benefits to both aviation safety and efficiency.

We wish you much success with this important proposal and look forward to future collaboration.

Sincerely,

David R. Bright

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From: Mark DeMaria - NOAA Federal <mark.demaria@noaa.gov>
Date: Sunday, April 21, 2013 8:06 PM
To: Michael Goodman <michael.goodman@nasa.gov>
Subject: Re: Lightning Imaging Sensor near real time processing

Michael:

[...]

I can see a number of areas where this data could be useful. This could be valuable for comparing with some of the ground-based networks we are using to test GOES-R GLM algorithms to predict rapid intensification. Thus, I endorse this project. When the time comes let me know what I would need to do to get the data.

Mark

On Sun, Apr 21, 2013 at 2:26 PM, Goodman, Michael (MSFC-ZP11) <michael.goodman@nasa.gov> wrote:

Dear Mark,

I believe we met at IHC or other hurricane events. If you don't remember, then let me reintroduce myself. I am a scientist at NASA Marshall Space Flight Center (MSFC) and I've taken part in a number of NASA hurricane field experiments including CAMEX, TCSP, NAMMA and GRIP. One of my roles at NASA is as the manager of the MSFC Global Hydrology Resource Center (GHRC), which is a NASA Distributed Active Archive Center (DAAC). The GHRC is the data archive for the aforementioned NASA hurricane experiments as well as the ongoing HS3 hurricane field campaign (PI: Scott Braun/GSFC). The GHRC is also the data processing and archive center for the LIS - Lightning Imaging Sensor (PI: Rich Blakeslee) aboard the TRMM satellite.

This past week, Rich Blakeslee and his LIS science team were notified that they have been given the final approval to fly the space-qualified LIS spare instrument on the International Space Station. The LIS spare was developed as a backup to the TRMM LIS and has been stored at MSFC since 1997. The instrument will be refurbished, and tested prior to launch aboard a SpaceX-10 rocket in January 2016. The LIS science team is excited and is looking forward to producing near real time (< 2 min) global total lightning observations under both day and night conditions from ~60N-60S. Total lightning observations include both cloud-to-ground and intra-cloud (cloud-to-cloud). Global total near real time lightning over the oceans and land surface has applications for use in forest fire initiation, aviation weather, severe storms and tropical cyclone modeling and forecasting.

NASA produces near real time data products from its satellite instruments through its LANCE (Land and Atmosphere Near real-time Capability for EOS) data system. LANCE (<http://lance.nasa.gov>) produces near real time data products from MODIS, OMI, AIRS and MLS. The GHRC at MSFC used to

process AMSR-E data for LANCE, but of course we no longer can since the failure of AMSR-E in Oct 2011. The MODIS, OMI, AIRS and MLS products are all processed by their respective data product teams and continue to provide products to the central LANCE server at NASA Goddard.

The AMSR-E LANCE data products were very successful and we received high marks from the LANCE management for our timely and consistent processing. The MSFC Global Hydrology Resource Center DAAC has approached the LANCE project with a request to process the LIS on TRMM data in near real time. Note: currently we are processing LIS data products for long term climatological research and generate lightning products within a threshold time limit on the order of ~12hrs. For the purpose of LANCE, near real time is considered < 3 hr. We are able to modify our processing scripts and turnaround a near real time TRMM LIS product in < 90 min. We have received positive feedback from LANCE management and they would like us to present the case for TRMM LIS near real time processing to the LANCE User Working Group in the first week of May. We have been asked to fill out a LANCE Enhancement Request, which describes the scientific objectives of the LIS near real time data, the concept of operations, implementation schedule, and cost. I've attached a draft version of the LANCE LIS request.

Processing the TRMM LIS near real time data for LANCE will serve as a precursor for the near real time processing of International Space Station LIS. So in addition to providing lightning data products in < 90 minutes we will be gaining valuable experience for the International Space Station LIS processing which will have a near real time turnaround of a couple of minutes.

The LANCE LIS Enhancement Request form (see attached file) asks us to identify potential users of LIS near real time data. We are gathering statements of support from the user community and are seeking feedback from you. Your role as key member of the tropical cyclone and mesoscale research community will be a valuable endorsement for TRMM LIS LANCE processing.

I hope you can support this request. If so, a positive email reply is all that is needed. If you have any questions please either call me or send an email.

Thank you and I look forward to your response.

--Michael

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